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A COMPARISISION OF ANTHROPOMETRICAL AND PHYSIOLOGICAL PARAMETERS OF MALE AND FEMALE RUNNER

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ABSTRACT

The purpose of the study was to compare and investigate the anthropometric and physiological parameters of male and female runners in the state of Chhattisgarh. Eighty adult male (N=44) and female (N=36) runners from different districts of Chhattisgarh were selected for the purpose of study. All the male and female runners of 200m, 400m, 800m and 10,000m were the members of respective district teams participating in open state athletic competitions (M/F). To compare the male and female runner on physical and physiological parameters: means, standard deviations and t–ratios were computed. The results of study revealed that the female runners were found taller, heavier and more fatty in comparison of male counter parts. Similarity was observed between male and female runners in their body mass index (BMI. Male runners were found to have greater in amount in all physiological parameters except peak flow expiratory rate (PFIR) than their counter parts. where as female runners were found to have greater degree of peak flow expiratory rate than did male runners. Male and female runners did not differ significantly in systolic blood pressure, pulse pressure and pulse rate parameters of physiology. Where as male and female runners had variation in diastolic blood pressure, mean arterial pressure (MRP) and peak flow expiratory rate (PFIR) parameters of physiology.

Keywords: Anthropometry, physiology, sexes, Runners, Parameters.

1. INTRODUCTION

Physical activity by sportsmen has been shown to increase muscular strength, reduce body fat and increase lean body mass, thus keeping BMI within physiological limits [Phillips, 2012].

Physiology of exercise has become an increasingly important topic for research and discussion over the past few years. Exercises are being prescribed either to prevent the disease or as an adjuvant to a patient during convalescence and rehabilitation. Lack of exercise is linked to cancer, diabetes and cardiac disease causing around ten percent of death in the planet. Approximately 2 million deaths per year are attributed to physical inactivity, prompting WHO to issue a warning that a sedentary lifestyle could very well be among the leading causes of death and disability in the world **[**Prakash, 2013).

Exercise has shown to increase muscular strength, reduce body fat and increase lean body mass, potentially decrease resting systolic and diastolic blood pressure, increase maximal oxygen consumption (VO2max), improve in cardiovascular / cardio-respiratory function(heart and lungs), increase maximal cardiac output, increase blood volume and ability to carry oxygen, increase blood supply to muscles and ability to use oxygen (Doyle, 1997) .

Height and weight variable may be useful, when they are identifying future athletes for training . A strong positive relationship between the height and weight of sports athletes and moderate positive relationship between the height and BMI in athletes was observed at the Australian Institute of Sport.

Body mass index (BMI), calculated as weight (kg) divided by the square of height (m^2) is an important index which can be used as a measure of percentage fat in an individual (Ani, Nku, Nna and Nwangwa, 2014; Ode , Pivarnik , Reeves and , Knous, 2007). The formula had already been proposed by the Belgian mathematician, Adolphe Quetelet, in the nineteenth century. The index has been used until today; it was previously named after its inventor but since 1972 it has been known as the "body mass index". Underweight BMI (<18.5) indicate that that your weight maybe too low, which can decrease your body's immune system, which could lead to illness. Normal BMI (18.5 - 24.9) range possess the ideal amount of body weight, associated with living longest, the lowest incidence of serious illness, as well as being perceived as more physically attractive than people with BMI in higher or lower ranges. Overweight BMI (25 to 29.9) range are considered overweight, which increased risk for a variety of illnesses For live in healthy ways, lower their weight, through diet and exercise. Obese BMI (>30) , which is also called physically unhealthy condition. The higher your BMI, the higher your risk for certain diseases such as heart disease, high blood pressure(hypertension), type 2 diabetes (High blood glucose), High LDL cholesterol , High triglycerides , Physical inactivity, gallstones, breathing problems and certain cancers.

Exercise has been documented to increase muscular strength, reduce body fat and increase lean body mass, potentially decreasing resting systolic and diastolic blood pressure [Doyle, 1997].

Blood pressure is defined as the force of blood pushing against the artery walls as blood circulates throughout the body. Blood must circulate at an appropriate pressure in order to sustain life. A healthy adult normally has a blood pressure of less than 120/80mmHg (millimeters of mercury). The first number is the systolic pressure which represents the pressure when the heart contracts. The second number is the diastolic pressure which is the pressure when the heart is resting between beats. Even though blood pressure varies within an individual, those with a pressure of 140/90mmHg or more for a sustained period of time is said to have high blood

pressure, also known as hypertension. A person with high systolic pressure and normal diastolic pressure is classified as hypertensive and the same applies for a person with high diastolic pressure and normal systolic pressure.

Blood pressure is a vital cardiovascular variable which has been documented to have an abstract association with body mass; a relationship that is poorly understood [Stamler, 1991].

The fundamental parameters defining hypertension in both adults and children do not differ in athletes . In the adult, hypertension is defined as a systolic BP ≥140 mmHg or a diastolic BP ≥90 mmHg "based on the average of two or more properly measured, seated BP readings on each of two or more office visits.

The mean arterial pressure (MAP) is a term used in medicine to describe an average blood pressure in an individual (Zheng , Sun and Li , 2008) . It is defined as the average arterial pressure during a single cardiac cycle. It is believed that a that is greater than 70 mmHg is enough to sustain the organs of the average person. is normally between 65 and 110 mmHg(Dnurse, 2007). If the falls below this number for an appreciable time, vital organs will not get enough Oxygen perfusion and will become hypoxic (A condition called ischemia). Pulse pressure is the difference between the systolic and diastolic pressure readings. It is measured in millimeters of mercury (mmHg) (Zheng , Sun and Li , 2008).

Pulmonary functional status was assessed by recording peak expiratory flow rate (PEFR). PEFR was selected because it is widely accepted as a reliable parameter of pulmonary functions and is simple to perform as a bed-side test. Hadorn introduced PEFR in 1942 and it was accepted as a parameter of pulmonary function test (PFT) in 1949 (Jain et.al., 1983; Kaur et.al., 2013; Sembulingam et.al., 2013) .

The PEFR has been defined by the European Respiratory Society as the maximal flow which is achieved during expiration that is delivered with maximal force starting from the level of maximal lung inflation. (Ebomoyi, and Iyawe, 2015). The peak expiratory flow rate (PEFR) is a person's maximum speed of expiration. It measures the airflow through the bronchi and thus the degree of obstruction in the airways. The peak expiratory flow rate (PEFR) is a test that measures how fast a person can exhale. PEFR is affected by changes in broncho-pulmonary structure and function. (Phillips, 2012). Swaminathan et al. (1993) measured the Peak expiratory flow rate in healthy South Indian Children aged 4-15 years using the wright's Mini peak flow meter. They found lower PEFR values in Indian children which could be due to an effect of lower lung volumes due to a smaller chest size. A study by Rastogi et al. (2009) in children having recurrent respiratory tract infection found altered PEFR in 67.6 percent patients. They also observed PEFR to be the most sensitive parameter to detect alteration in lung function. Gundogdu Z, Eryilmaz N (2011) revealed that PEFR values were lower in obese children than in non-obese children. There were also significant differences between girls and boys. The association of higher BMI with lower PEFR may indicate that obesity is an important risk factor for reduced airflow or lung function in children.

The purpose of the study was to compare and investigate the anthropometric and physiological parameters of male and female runners in the state of Chhattisgarh.

2. METHODOLOGY

2.1 . Sample

Eighty adult male (N=44) and female (N=36) runners from different districts of Chhattisgarh were selected for the purpose of study. All the male and female runners of 200m, 400m, 800m and 10,000m were the members of respective district teams participating in open state athletic competitions (M/F) held at South East Central Railway (SECR) Cricket Play

Ground from 11/06/2016 to 13/06/2016 and volunteered to participate for this study. The average age of male and female runner was 22.78 ± 2.26 and 21.32±2.08 respectively.

2.2 Experimentation

All participants were contacted at the site of their competition venue as well as staying place during competition and underwent for the measurement of anthropometric variables and physiological parameters. Oral and written informed consent was taken from all the participants, coaches and managers of the respective teams before testing them.

Measurement of Weight and Height: After all outer clothing and shoes were removed, the body weight and height were measured by using digital weighing machine and height with stadiometer to the nearest 0.1 kg and 0.1 cm, respectively.

Determination of Body Mass Index (BMI): BMI of each subject was obtained mathematically using the formula: BMI = Weight (Kg)/Height (m2). where underweight was < 18.5 kg/m2, normal 18.5– 24.9 kg/m2, overweight 25.0–29.9 kg/m2 and obese ≥ 30.0kg/m2 (World Health Organization, 2006).

Measurement of Blood Pressure: Resting blood pressure (RBP) was measured three times at five minutes intervals using a digital blood pressure monitor according to standardized guidelines. The children were seated with the arm cuff and zero indicators on the monitor at the level of the examiner's eye. All the readings were taken in triplicate on the right arm. Each subjects reading was obtained thrice after which the average was used as the subject's blood pressure.

Determination of Mean Arterial Pressure and Pulse Pressure From the BP measurements, the mean arterial pressure (MAP) was derived using the formula: MAP = DBP + ⅓ (SBP – DBP). Pulse pressure (PP) was calculated as the difference between SBP and DBP (Zheng, et. al., 2008).

Measurement of Pulse Rate : The pulse rate was also taken by palpating the radial artery at the wrist for one minute using the stopwatch.

Measurement of Peak Expiratory Flow Rate : Peak expiratory flow rate was measured using the JSB peak flow meter (JSB Health Care Pvt. limited, New Delhi). The subject was asked to inhale deeply and then exhale maximally through the mouth piece of the device. The reading was taken thrice, after which the highest of the three readings was recorded as the PEFR.

2.3 Data Analysis:

Statistical analysis was done using SPSS version 16.0.Values were analyzed based on age, sex, BMI, and PEFR. The t- test was used to compare the mean for male and female at $P < 0.05$. The ANOVA was used to compare the various mean for the BMI group at $P < 0.05$.

3. RESULTS

To compare the male and female runner on physical and physiological parameters: means, standard deviations and t–ratios were computed. The level of significance was set at .05 level and data pertaining to this has been presented in Table 1 to 4.

TABLE 1

DESCRIPTIVE STATISTICS OF ANTROPOMETRIC PARAMETERS OF MALE AND FEMALE RUNNER OF CHHATTISGARH

S.No.	Variables	Sex	N	M	SD
1.	Age (yrs)	Male	22	22.78	2.26
		Female	18	21.32	2.08
2	Height (cm.)	Male	22	156.23	4.39
		Female	18	163.06	8.66
3	Weight (kg.)	Male	22	48.05	4.79
		Female	18	55.61	5.51
4	Body Mass Index	Male	22	19.00	4.79
		Female	18	20.53	2.62

The mean scores of male and female runner of Chhattisgarh state on anthropometric parameters have been depicted in figures 1 to 4.

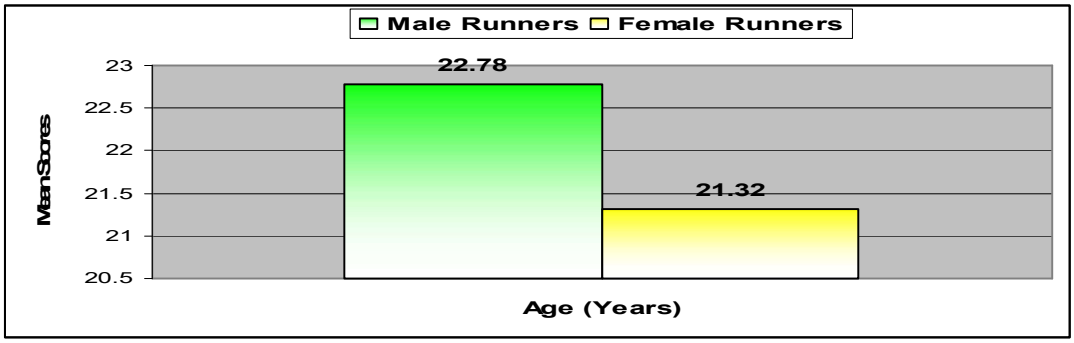

Figure:1-Mean Scores of Age of Male and Female Runners of Chhattisgarh State

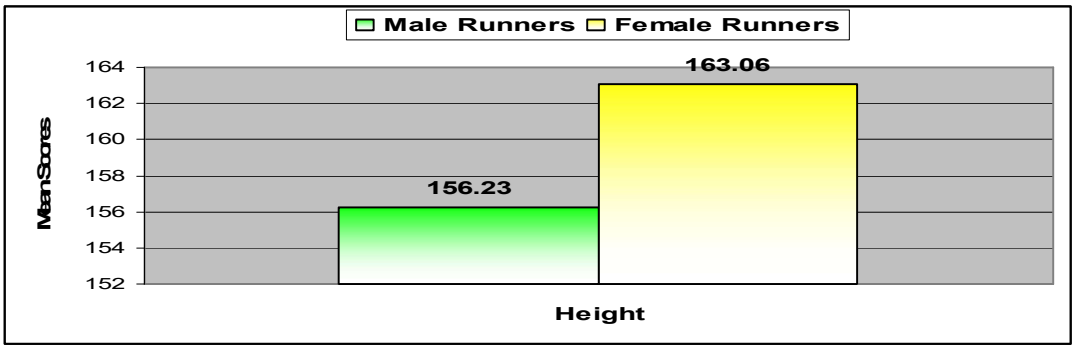

Figure:2-Mean Scores of Height of Male and Female Runners of Chhattisgarh State

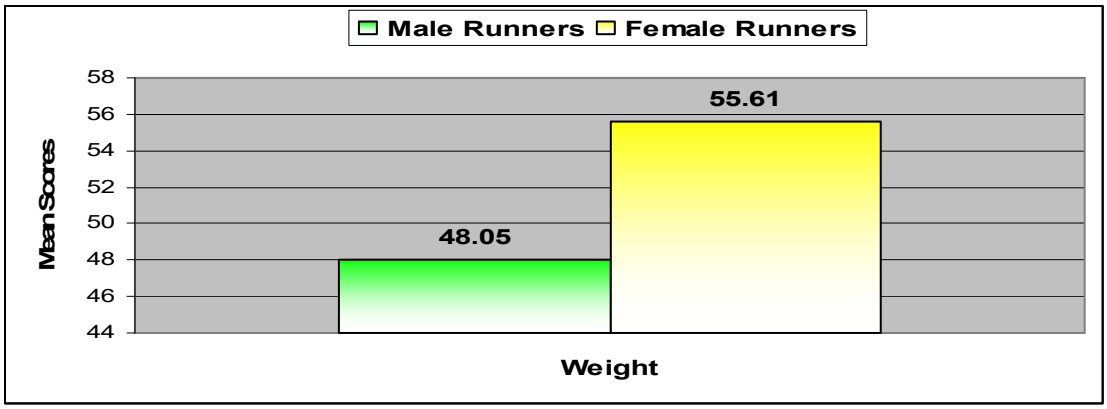

Figure:3-Mean Scores of Weight of Male and Female Runners of Chhattisgarh State

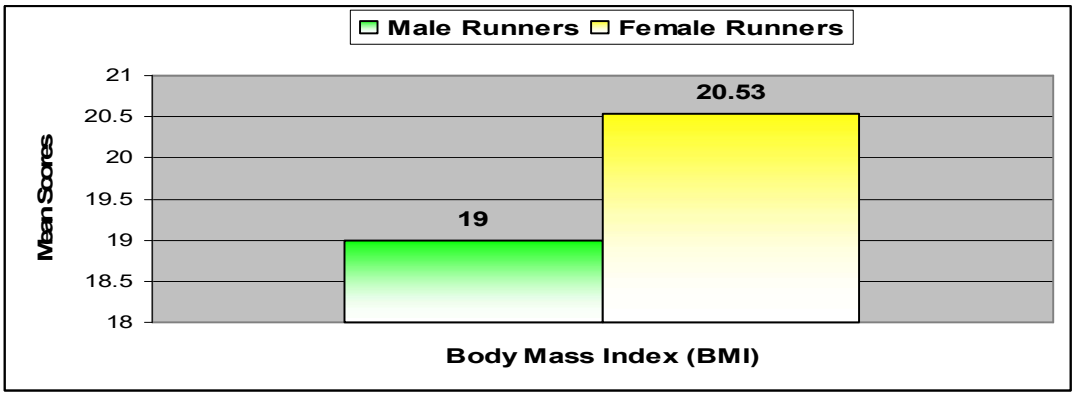

Figure:4-Mean Scores of BMI of Male and Female Runners of Chhattisgarh State

TABLE 2
SIGNIFICANCE OF DIFFERENCE BETWEEN MALE AND FEMALE RUNNERS OF CHHATISGRH ON ANTHROPOMETRIC PAPRAMETERS

S. No.	Variables	Sex	Mean	MD	σ DM	t-ratio
1.	Age (yrs)	Male Female	22.78 21.32	1.46	0.48	3.04*
1.	Height (cm.)	Male Female	156.23 163.06	6.83	2.24	3.23*
2.	Weight (kg.)	Male Female	48.05 55.61	7.56	1.62	4.65*
3.	Body Mass Index (BMI)	Male Female	19.00 20.53	1.53	.0.83	1.84

*Significant at .05 level
t.05 (38) = 2.02

It is evident from Table 2, that statistically significant differences were found between male and female runners on age, height, weight, and BMI, as the obtained t-values of 3.04, 3.23, and 4.65, respectively were higher than the required value of t.05(38)=2.02. But the significant difference was not found between male and female runners on body mass index , as the obtained t-values of 1.84 was less than the required value of t.05(38)=2.02..

TABLE 3
DESCRIPTIVE STATISTICS OF PHYSIOLOGICAL PARAMETERS OF MALE AND FEMALE RUNNER OF CHHATTISGARH

S. No.	Variables	Sex	N	M	SD
1	Systolic Blood Pressure (mmHg).	Male Female	22 18	128.00 118.11	10.18 15.99
2	Diastolic Blood Pressure (mmHg).	Male Female	22 18	78.09 69.28	7.79 12.69
3	Mean Arterial Pressure (mmHg).	Male Female	22 18	75.81 93.54	28.38 8.87
4	Pulse pressure (mmHg).	Male Female	22 18	48.83 47.91	10.67 8.19
5	Pulse Rate (Beat/Minute)	Male Female	22 18	95.23 94.39	13.81 15.08
6	PEFR (Peak Expiratory Flow Rate) –LPM	Male Female	22 18	309.95 436.00	44.59 54.28

The mean scores of male and female runner of Chhattisgarh state on physiological parameters have been depicted in figures 5 to 10.

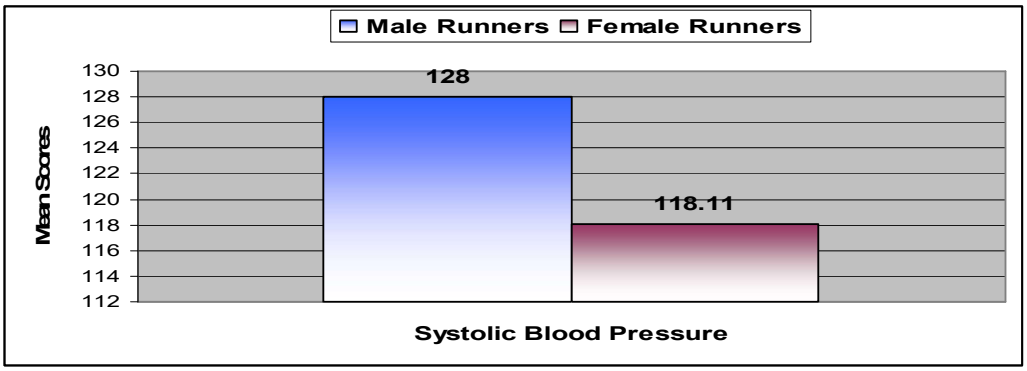

Figure:5-Mean Scores of Systolic Blood Pressureof Male and Female Runners of Chhattisgarh State

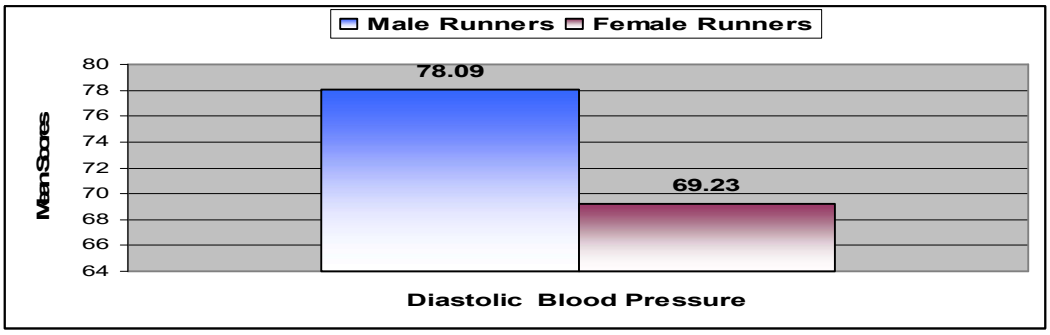

Figure:6-Mean Scores of Diastolic Blood Pressure of Male and Female Runners of Chhattisgarh State

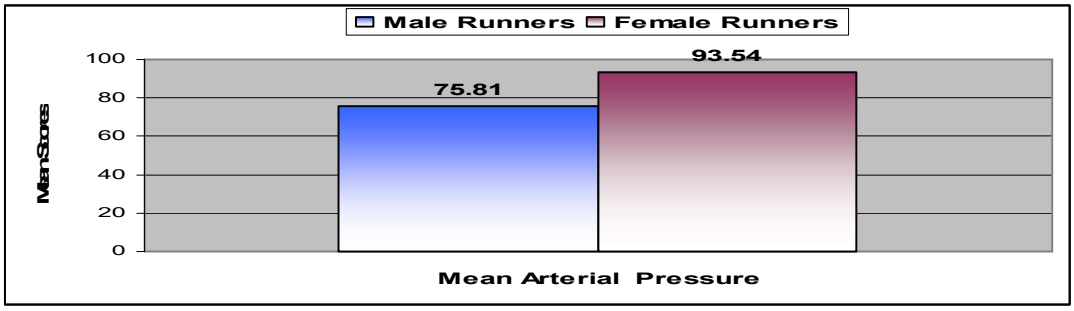

Figure:7-Mean Scores of Mean Arterial Pressure of Male and Female Runners of Chhattisgarh State

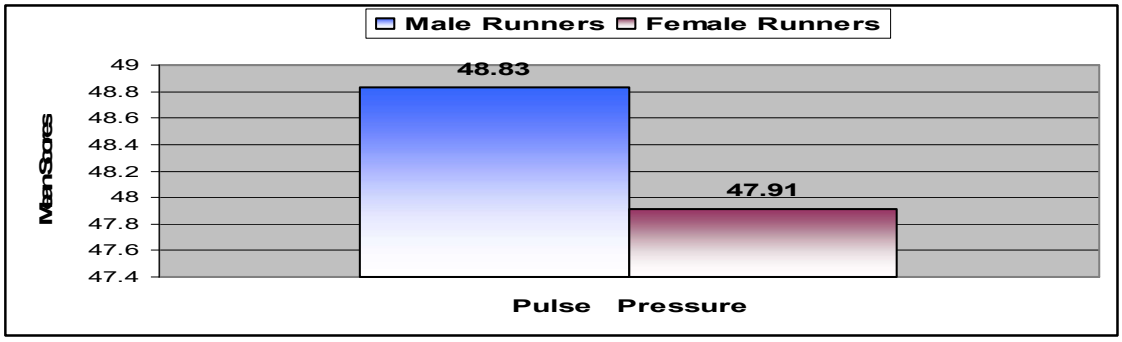

Figure:8-Mean Scores of Pulse Pressure of Male and Female Runners of Chhattisgarh State

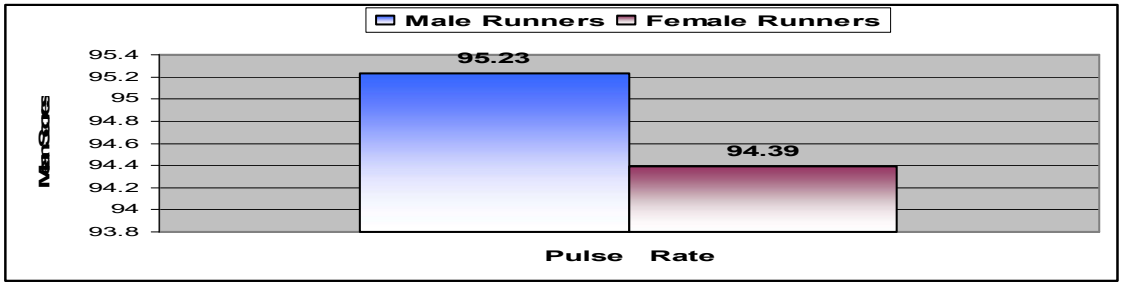

Figure: 9-Mean Scores of Pulse Rate of Male and Female Runners of Chhattisgarh State

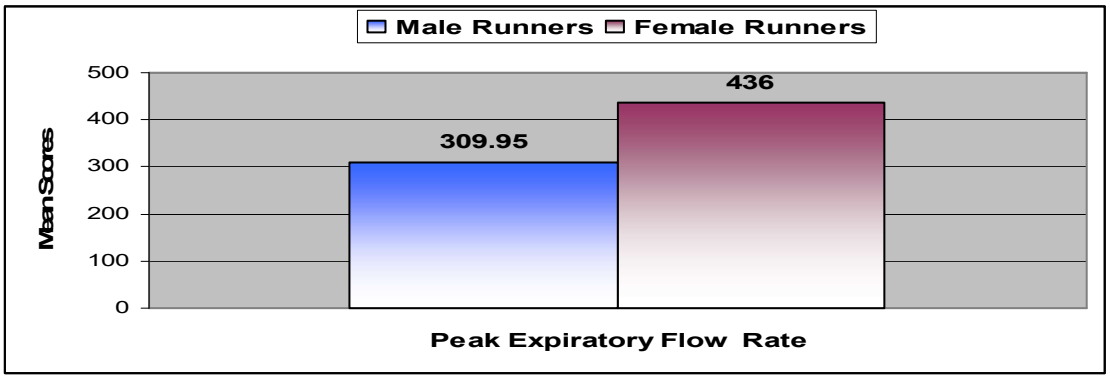

Figure: 10-Mean Scores of Peak Expiratory Flow Rate of Male and Female Runners of Chhattisgarh State

TABLE 4
SIGNIFICANCE OF DIFFERENCE BETWEEN MALE AND FEMALE RUNNERS OF CHHATISGRH ON PHYSIOLOGICAL PAPRAMETERS

S. No.	Variables	Sex	Mean	MD	σ DM	t-ratio
1	Systolic Blood Pressur (mmHg).	Male Female	128.00 118.11	9.89	4.16	1.89
2	Diastolic Blood Pressu (mmHg).	Male Female	78.09 69.28	8.81	3.27	2.69*
3	Mean Arterial Pressure (mmHg).	Male Female	75.81 93.54	17.73	5.98	2.96*
4	Pulse pressure (mmHg).	Male Female	48.83 47.91	0.92	2.98	0.31
5	Pulse Rate (Beat/Minute)	Male Female	95.23 94.39	0.84	4.57	0.18
6	PEFR	Male Female	309.95 436.00	126.05	15.62	8.07*

*Significant at .05 level
t.05 (38) = 2.02

It is evident from Table 4, that statistically significant differences were found between male and female runners on diastolic pressure, mean arterial pressure and peak expiratory flow rate, as the obtained t-values of 2.69, 2.96 and 8.07 respectively were higher than the required value of t.05(38)=2.02. But the significant differences were not found between male and female runners on systolic blood pressure, pulse pressure and pulse rate, as the obtained t-values of 1.89, 0.31 and 0.18 respectively were less than the required value of t.05(38)=2.02.

4. DISCUSSION

The descriptive statistics for anthropometric parameters i.e. age, height, weight , and body mass index (BMI values) was computed in a sample of 40 subjects from state of Chhattisgarh and presented in table-1. The mean values of age and height for the male runners were 22.78±2.26 yrs and 156.23±4.39 cm respectively while that for male runners were significantly higher ($p<0.05$) than their female counter parts. Weight mean value for male runners(48.05± 4.79 kg) was significantly lower than that for female runners 55.61± 5.51 kg making an overall mean difference in weight of 7.56. BMI kg/m^2 mean value for female runners (20.53±2.62 kg/m^2) were higher than that for male runners(19.00±4.79 kg/m^2) making an overall mean difference in BMI of 1.53 kg/m2. The male and female runners were found to have a normal BMI values. BMI is a useful measure of overweight and obesity. It is calculated from your height and weight. BMI is an estimate of body fat and a good gauge of your risk for diseases that can occur with more body fat.

To find out the significant difference between male and female runners in their anthropometric parameters, t-ratio was computed and data pertaining to this has been presented in table2. The results of the data analysis revealed the statistically significant differences between male and female runners on age, height and weight. But the significant difference was not found between male and female runners on body mass index

The descriptive statistics for physiological parameters i.e. systolic blood pressure , diastolic pressure, mean arterial pressure , pulse pressure and peak expiratory flow rate, was computed in a sample of 40 subjects from state of Chhattisgarh and presented in table-3. The mean values of diastolic pressure (78.09±7.79 mmHg) and mean arterial pressure(75.81±8.38 mmHg) for the male runners were significantly higher ($p<0.05$) than their female counter parts. But the mean value for male runners of PEFR (309.95±44.59 LPM)) was significantly lower than that for female runners (436.00± 54.28 LPM). Mean arterial pressure (MAP) is the perfusion pressure felt by organs in the body. A person has a MAP of 80. The MAP falls below 60 significantly below this number for an appreciable time, vitals organs will be under perfused and will become ischemi. The mean values of systolic blood pressure (128.00±10.18 mmHg) , pulse pressure(48.83.00±10.67 mmHg) and pulse rate (95.23±13.81 beat/minute) for the male runners were also higher, but insignificant than their female counter parts. An increased pulse pressure from 40 may occur during exercise or in individuals with atherosclerosis of the larger arteries due to increased SBP. A decreased pulse pressure may be found in cardiac failure or hypovolemia.

To find out the significant difference between male and female runners in their physiological parameters, t-ratio was computed and data pertaining to this has been presented in table4. The results of the data analysis revealed the statistically significant differences were found between male and female runners on diastolic pressure, mean arterial pressure and peak expiratory flow rate. But the significant differences were not found between male and female runners on systolic blood pressure, pulse pressure and pulse rate

5. CONCLUSIONS

1. Female runners were found taller, heavier and more fatty in comparison of male counter parts.
2. Male and female runners were found free from health hazards .
3. Significant difference was found between male and female runners on age, height, weight .

4. Insignificant difference was observed between male and female runners in their body mass index (BMI.
5. Male runners were found to have greater in amount in all physiological parameters except peak flow expiratory rate (PFIR) than their counter parts.
6. Female runners were found to have greater degree of peak flow expiratory rate than did male runners.
7. Male and female runners did not differ significantly in systolic blood pressure, pulse pressure and pulse rate parameters of physiology.
8. Male and female runners had variation in diastolic blood pressure, mean arterial pressure (MRP) and peak flow expiratory rate (PFIR) parameters of physiology

6. FUTURE DIRECTION FOR RESEARCH

1. Present investigation may be conducted on athletes of team, individual and combat games.
2. Study may be replicated on more population of runners at their participation of different levels.
3. Correlation study may be conducted between anthropometric and physiological parameters of male and female runners.

REFERENCES

Ani EJ, Nku CO, Nna VU, Nwangwa JN. Int J Sci Res 2014;3: 2028-2031.

Cohen, Deborah A and Roland Sturm, Body mass index is increasing faster among taller persons Am J Clin Nutr February 2008 vol. 87 no. 2 445-448.

Doyle JA. The Exercise and Physical Fitness Web Page: Master of Science program in Exercise Science in the Department of Kinesiology and Health at Georgia State University, 1997

Dua, Suman , Monika Bhuker, Pankhuri Sharma, Meenal Dhall, and Satwanti Kapoor Body Mass Index Relates to Blood Pressure Among Adults N Am J Med Sci. 2014 Feb; 6(2): 89–95.

Droyvold, W. B., K Midthjell, T I L Nilsen and J Holmen, Change in body mass index and its impact on blood pressure: a prospective population study International Journal of Obesity (2005) 29, 650–655. doi:10.1038/sj.ijo.0802944 Published online 5 April 2005.

Dnurse, E (May 31, 2007). "mean arterial pressure". Archived from the original *on* December 12, 2013. Retrieved 2013-12-12. impactednurse.com

Ebomoyi , MI, Iyawe V . Nig J Physiol Sci 2005;20: 85-89

Gundogdu, Z, Eryilmaz N. Correlation between peak flow and body mass index in obese and non-obese children in Kocaeli, Turkey. Prim Care Respir J. 2011 Dec;20(4):403-6. doi: 10.4104/pcrj.2011.00061.

Jain, SK, Kumar R, Sharma DA. Factors influencing peak expiratory flow rate in normal subjects. Lung India, 1983; 3: 92-97.

Kraemer, WJ, Torine JC, Silverstre R, French DN, Ratamess NA, Spiering BA, Hatfield DL, Vingren JL, & Volek JS. Body size and composition of national football league players. Journal of Strength and Conditioning Research. 2005; 19 (3): 485-489.

Kruschitz, R, Wallner-Liebmann SJ, Hamlin MJ, Moser M, Ludvik B, Schnedl WJ, & Tafeit E. Detecting body fat – a weighty problem BMI versus subcutaneous fat patterns in athletes and non-athletes. PLOS One. 2013; 8 (8): 1-9.

Kaur, Harpreet; Jagseer Singh, ManishaMakkar, Khushdeep Singh, RuchikaGarg. Variations in the Peak Expiratory Flow Rate with Various Factors in a Population of Healthy Women of the Malwa Region of Punjab.J ClinDiagn **Res., 2013; 7(6): 1000–1003**

Lambert, BS, Oliver JM, Katts GR, Green JS, Martin SE, & Crouse SF. DEXA or BMI: clinical considerations for evaluating obesity in collegiate division I-A American football athletes. Clinical journal of sport medicine: official journal of the Canadian Academy of Sport Medicine. 2012; 22(5): 436–438.

Mandel, D, Zimlichman E, Mimouni FB, Grotto I, Kreiss Y Height-related changes in body mass index: a reappraisal. J Am Coll Nutr. 2004 Feb;23(1):51-4.

Mathews EM, & Wagner DR. Prevalence of overweight and obesity in collegiate American football players, by position. Journal of American College Health. 2008; 57 (1): 33-37.

Mazic S, Djelic M, Suzic J, Suzic S, Dekleva M, Radovanovic D, Scepanovic L, & Starcevic V. Overweight in trained subjects – are we looking at wrong numbers? (Body mass index compared with body fat percentage in 36 estimating overweight in athletes.). General Physiology and Biophysics. 2009; 28: 200-204.

Nevill AM, Stewart AD, Olds T, & Holder R. Relationship between adiposity and body size reveals limitations of BMI. American Journal of Physical Anthropology. 2006; 129: 151-156.

Nevill AM, Winter EM, Ingham S, Watts A, Metsios GS, & Stewart AD. Adjusting athletes' body mass index to better reflect adiposity in epidemiological research. Journal of Sports Sciences. 2012; 28(9): 1009-1016

Martins D, Tareen N, Pan D, and Norris K. The relationship between body mass index, blood pressure and pulse rate among normotensive and hypertensive participants in the third National Health and Nutrition Examination Survey (NHANES). Cell Mol Biol (Noisy-le-grand). 2003 Dec;49(8):1305-9.

Mungreiphy, N. K. Satwanti Kapoor, and Rashmi Sinha, Association between BMI, Blood Pressure, and Age: Study among Tangkhul Naga Tribal Males of Northeast India Journal of Anthropology Volume 2011 (2011), Article ID 748147, 6 pages http://dx.doi.org/10.1155/2011/748147

National Heart, Lung And Blood Institute/National High Blood Pressure Education Program: Nhbpep Coordinating Committee (1987). Report of the second task force on blood pressure control in children. Pediatrics 1987;79:25.

Ode JJ, Pivarnik JM, Reeves MJ, Knous JL. Med Sci Sports Exerc 2007;39:403-409.

PCG Diverse , Weight-height relationships and body mass index: some observations from the Diverse Populations Collaboration. Am J Phys Anthropol. 2005 Sep;128(1):220-9.

Phillips N, Peak Expiratory Flow Rate, Medically Reviewed by George Krucik, MD Healthline, 2012.

Prakash R, Physical inactivity a leading cause of disease and disability, warns WHO, World Health Organization Media Centre,2013.

Rastogi A, Sharma P and Nigam KS, Assessment of Lung Function (Spirometry) in Children with Recurrent Upper Respiratory Tract Infection, Indian J. Allergy Asthma and Immunol., 23 (2), 2009, 83-87

Swaminathan, S et al., Peak Exploratory Flow Rate in south Indian Children, Indian Pediatrics,30, 1993.

Sembulingam, K. Prema Sembulingam, V. Poornodai, Gigi Chandran. Effect of oil pulling on peak expiratory flow rate. International Journal of Research in Health Sciences, 2013; 1(3): 136.

Sperrin, Matthew , Alan D. Marshall, Vanessa Higgins, Andrew G. Renehan, and Iain E. Buchan, Body mass index relates weight to height differently in women and older adults: serial cross-sectional surveys in England (1992–2011) *J Public Health* (2015) doi: 10.1093/pubmed/fdv067 First published online: June 1, 2015 June 2016 38 (2)

Stamler J. Ann Epidemiol 1991; 1: 347-362.

World Health Organization: BMI Classification, WHO Global Database on Body Mass (2006)

Zheng , L, Sun Z, Li J. Pulse pressure and mean arterial pressure in relation to ischemic stroke among patients with uncontrolled hypertension in rural areas of China. Stroke 2008;39:1932-7.